

CLAIMS

1. A nonaqueous electrolyte secondary battery characterized as using a mixture of a first oxide and a second oxide for its positive electrode material, said first oxide being a spinel oxide consisting substantially of lithium, manganese, a metal other than manganese, and oxygen, and said second oxide being different from the first oxide and consisting substantially of lithium, nickel, cobalt, a metal other than nickel and cobalt, and oxygen.

2. The nonaqueous electrolyte secondary battery as recited in claim 1, characterized in that said first oxide is an oxide derived via substitution of other element for a part of manganese in a lithium-manganese complex oxide and said second oxide is an oxide derived via substitution of cobalt and other element for a part of nickel in a lithium-nickel complex oxide.

3. The nonaqueous electrolyte secondary battery as recited in claim 1 or 2, characterized in that said first oxide is a lithium-manganese complex oxide represented by the compositional formula $\text{Li}_x\text{Mn}_{2-y}\text{Ml}_y\text{O}_{4+z}$ (where, Ml is at least one element selected from the group consisting of Al, Co, Ni, Mg and Fe, $0 \leq x \leq 1.2$, $0 < y \leq 0.1$ and $-0.2 \leq z \leq 0.2$).

4. The nonaqueous electrolyte secondary battery as

recited in any one of claims 1 - 3, characterized in that said second oxide is represented by the compositional formula $\text{Li}_a\text{M2}_b\text{Ni}_c\text{Co}_d\text{O}_2$ (where, M2 is at least one element selected from the group consisting of Al, Mn, Mg and Ti, $0 < a < 1.3$, $0.02 \leq b \leq 0.3$, $0.02 \leq d/(c + d) \leq 0.9$ and $b + c + d = 1$).

5. The nonaqueous electrolyte secondary battery as recited in claim 3, characterized in that M1 in the first oxide's compositional formula $\text{Li}_x\text{Mn}_{2-y}\text{M1}_y\text{O}_{4+z}$ is at least one of Al and Mg.

6. The nonaqueous electrolyte secondary battery as recited in claim 4, characterized in that M2 in the second oxide's compositional formula $\text{Li}_a\text{M2}_b\text{Ni}_c\text{Co}_d\text{O}_2$ is Mn.

7. The nonaqueous electrolyte secondary battery as recited in claim 6, characterized in that $0.1 \leq d/(c + d) \leq 0.5$ is satisfied in the second oxide's compositional formula $\text{Li}_a\text{M2}_b\text{Ni}_c\text{Co}_d\text{O}_2$.

8. The nonaqueous electrolyte secondary battery as recited in any one of claims 1 - 7, characterized in that said first and second oxides are mixed in the ratio by weight of 20:80 - 80:20.

9. The nonaqueous electrolyte secondary battery as recited in any one of claims 1 - 8, characterized in that said first oxide has a mean particle diameter of 5 - 30 μm .

10. The nonaqueous electrolyte secondary battery as

recited in any one of claims 1 - 9, characterized in that said second oxide has a mean particle diameter of 3 - 15 μm .

11. A nonaqueous electrolyte secondary battery characterized as using a mixture of a first oxide, a second oxide and a third oxide for its positive electrode material, said first oxide being a spinel oxide consisting substantially of lithium, manganese, a metal other than manganese, and oxygen, said second oxide being different from the first oxide and consisting substantially of lithium, nickel, cobalt, a metal other than nickel and cobalt, and oxygen, and said third oxide being different from the first and second oxides and consisting substantially of lithium, cobalt and oxygen or of lithium, cobalt, a metal other than cobalt, and oxygen.

12. The nonaqueous electrolyte secondary battery as recited in claim 11, characterized in that said first oxide is an oxide derived via substitution of other element for a part of manganese in a lithium-manganese complex oxide, said second oxide is an oxide derived via substitution of cobalt and other element for a part of nickel in a lithium-nickel complex oxide, and said third oxide is a lithium-cobalt complex oxide or an oxide derived via substitution of other element for a part of cobalt in said lithium-cobalt complex oxide.

13. The nonaqueous electrolyte secondary battery as

recited in claim 11 or 12, characterized in that said first oxide is a lithium-manganese complex oxide represented by the compositional formula $\text{Li}_x\text{Mn}_{2-y}\text{M1}_y\text{O}_{4+z}$ (where, M1 is at least one element selected from the group consisting of Al, Co, Ni, Mg and Fe, $0 \leq x \leq 1.2$, $0 < y \leq 0.1$ and $-0.2 \leq z \leq 0.2$).

14. The nonaqueous electrolyte secondary battery as recited in any one of claims 11 - 13, characterized in that said second oxide is represented by the compositional formula $\text{Li}_a\text{M2}_b\text{Ni}_c\text{Co}_d\text{O}_2$ (where, M2 is at least one element selected from the group consisting of Al, Mn, Mg and Ti, $0 < a < 1.3$, $0.02 \leq b \leq 0.3$, $0.02 \leq d/(c + d) \leq 0.9$ and $b + c + d = 1$).

15. The nonaqueous electrolyte secondary battery as recited in any one of claims 11 - 14, characterized in that said third oxide is represented by the compositional formula $\text{Li}_e\text{M3}_f\text{Co}_{1-f}\text{O}_2$ (where, M3 is at least one element selected from the group consisting of Al, Mn, Mg and Ti, $0 < e < 1.3$ and $0 \leq f \leq 0.4$).

16. The nonaqueous electrolyte secondary battery as recited in claim 13, characterized in that M1 in the first oxide's compositional formula $\text{Li}_x\text{Mn}_{2-y}\text{M1}_y\text{O}_{4+z}$ is at least one of Al and Mg.

17. The nonaqueous electrolyte secondary battery as recited in claim 14, characterized in that M2 in the second

oxide's compositional formula $\text{Li}_a\text{M}_2\text{Ni}_c\text{Co}_d\text{O}_2$ is Mn.

18. The nonaqueous electrolyte secondary battery as recited in claim 17, characterized in that $0.1 \leq d/(c + d) \leq 0.5$ is satisfied in the second oxide's compositional formula $\text{Li}_a\text{M}_2\text{Ni}_c\text{Co}_d\text{O}_2$.

19. The nonaqueous electrolyte secondary battery as recited in claim 15, characterized in that said third oxide is represented by the compositional formula $\text{Li}_e\text{M}_3\text{Co}_{1-f}\text{O}_2$ (where, M3 is at least one element selected from the group consisting of Mg and Ti, $0 < e < 1.3$ and $0.02 \leq f \leq 0.2$).

20. The nonaqueous electrolyte secondary battery as recited in any one of claims 11 - 19, characterized in that said first, second and third oxides are mixed in the ratio by weight of (first oxide) to (second oxide + third oxide) = 20:80 - 80:20.

21. The nonaqueous electrolyte secondary battery as recited in claim 20, characterized in that said second and third oxides are mixed in the ratio by weight of (second oxide) to (third oxide) = 90:10 - 10:90.

22. The nonaqueous electrolyte secondary battery as recited in any one of claim 11 - 21, characterized in that said first oxide has a mean particle diameter of 5 - 30 μm .

23. The nonaqueous electrolyte secondary battery as recited in any one of claim 11 - 22, characterized in that said second oxide has a mean particle diameter of 3 - 15 μm .

24. The nonaqueous electrolyte secondary battery as recited in any one of claim 11 - 23, characterized in that said third oxide has a mean particle diameter of 3 - 15 μm .

09914653-083101
TOTEBD-ES94T660